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Soil fertility evaluation of inceptisol order from Ausa Tahsil of Latur District

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Abstract
The present investigation was undertaken for assessing the fertility status in *Inceptisols* of Ausa tahsil in Latur District, for this purpose total 100 soils samples were systematically collected from 20 villages by using global positioning system where 50 samples identified as Inceptisols which were analyzed for their Physico-chemical properties (soil pH, Electrical conductivity, organic carbon and calcium carbonate) and available nutrients (Nitrogen, Phosphorus and Potassium). The soils of Ausa tahsil were found neutral to moderately alkaline in reaction; soluble salt content comes under safe Limit *i.e.* no any deleterious effect found for all crops, where the organic carbon level exhibited low to moderately high content and non-calcareous to calcareous in nature. The *Inceptisols* of the area showed low to moderate content in Available N and P, whereas most of the samples were found under very high content for Available K. The Physico chemical properties (pH, EC, OC and $CaCO_3$) of soils from order Inceptisols showed strongly positive and significant relation with available nutrients (N, P and K) however $CaCO_3$ showed non-significant relation with available K.

Keywords: Fertility status, Inceptisols, Physico chemical properties, available nutrients, Nutrient index

Introduction
Soil is a vital resource, can be termed as 'Soul of infinite life'. The essence of life in the soil is its crop producing capacity *i.e.* the soil productivity largely depends on soil fertility, management practices and climate. These agricultural practices can be managed, while the climate is natural factor which influences the soil fertility. Therefore, soil fertility is the major component of productivity which primarily deals with nutrient supplying capacity of the soil to the plant. Thus, it has been always considered to carry out genetic study as well as to find out fertility evaluation for making best use of the soil for crop production (Anonymous 2011) [1].
The Nitrogen is an essential constituent of chlorophyll, amino acids, protoplasm, protein and nucleic acid. Phosphorus is the structural component and energy store house of plant cell, required for early root development and growth. The Potassium is important for increasing the disease resistance in plants and plays important catalytic role in activating enzymes, also improves quality of the produce as well. Intensive cropping with imbalance fertilizer and water uses, lack of efficient management results in deficiency of these nutrients.
Hence Soil fertility must be periodically estimated because there is continuous removal of macro nutrients by the crop intensively grown in every crop season. Due to continuous cropping system for periods without adequate supply of additional amounts of nutrients, there is every possibility of deficiencies of essential nutrients in due course of time. For this reason, recent interest in evaluating the fertility status for maintaining soil quality of our soil resources has been stimulated by increasing awareness that the soil is critically important component of earths biosphere, functioning not only in the production of food and fibre but also in the maintenance of local, regional and worldwide environmental quality (Dadhwal *et al.* 2011) [3].
Thus, Keeping this view in mind an attempt is made to assess soil fertility evaluation of soybean growing area from Ausa tahsil of Latur district.

Materials and Methods
The Latur is situated on the south east Fringe of Maharashtra state with semi-arid tropical region. The major portion of this district is comes under lateritic plateau with an average height of about 609.6 above MSL. Ausa is one of the major tahsil situated at south west side of Latur.

Latur district is located between N 17° 55' N 18° 50' North and E 76°15' E 77°15' east respectively, whereas soils from these area belongs to the order vertisol, Inceptisols and Entisols derived from Deccan trap. The soil varied in different colour due to presence ofminerals like smectite, kaolinite and vermiculite. On the basis of soil depth and texture, these soils have been classified into deep to medium black and shallow black soils (Gajbe *et al.* 1976). Soil samples collected from the study area were dried and crushed with the help of wooden rod and passed through 2 mm sieve and then used for the determination of Physico chemical properties and available nutrient content by adopting standard laboratory method. Soil pH and Electrical conductivity (E.C.) in 1:2.5 soil water suspension was determined by Jackson (1973) [6]. Modified method of Walkley and Black (1934) [17] was used for determination of organic carbon. The free calcium carbonate was determined by rapid titration method as outlined by Piper (1966), available nitrogen was estimated by alkaline $KMnO_4$ method given by Subbiah and Asija (1956) [13], available phosphorus was extracted by 0.5M $NaHCO_3$ solution buffer at pH 8.5 given by Olsen *et al.* (1954) whereas available potassium was extracted shaking with ammonium acetate and determined by flame photometer given by Jackson (1973) [6] respectively. Whereas the nutrient index approach introduced by Ramamurthy and Bajaj (1969) [12] was used to evaluate the fertility status of soils based on the samples in each of the six classes. The whole data was subjected to statistical analysis by the method described by Panse and Sukhatme (1967) [10].

Results and Discussion

Status of Physico chemical properties in soils of Ausa Tahsil

Soil pH of Ausa tahsil varied from 7.1 to 8.6 having a mean of 7.72 in Inceptisols (Table 1). Out of 50 soil samples grouped under Inceptisols 17 (34 per cent) soil samples were neutral and 32 (64 per cent) soil samples were moderately alkaline while 1 sample (2 per cent) was found under strong alkaline in reaction. Thus most of the soils were found moderately alkaline in nature (Table 2 and figure 1). This might be due to the fact that the parent material of these soils was basalt, also the applied fertilizers when reacts with soil colloids results basic cation retention on exchangeable complex of soil, also the dominance presence of exchangeable Ca, Mg and free $CaCO_3$ with higher per cent of base saturation might be the reason, Waghmare *et al.* (2008) [19] recorded that the soils of Ausa tahsil ranged from 7.05 to 8.9 with an average value of 8.07.

The organic carbon content showed that these soils were ranges from 3.1 to 7.5 g kg^{-1} with mean value 5.2 g kg^{-1} (Table 1), It's seen that, from 50 no of samples in Inceptisols, 6 samples (12 per cent) were low, 33 samples (66 per cent) were found moderate while 11 samples (22 per cent) were noted under moderately high in organic carbon (Table 2 and figure 2). Reason behind the existence of variation in organic carbon content as Lower to medium range might be due to high temperature of Latur District (up to 41.5) and good aeration in the soil increased the rate of oxidation of organic matter resulting reduction of organic carbon content. Inadequate supply of organic manures and use of imbalanced chemical fertilizers along with poor agricultural management practices like soil tillage, mono or diversified cropping pattern, burning of trashes after harvesting etc. Dhamak *et al.* (2014) [2] found that soils from orders Vertisols, Inceptisols and Entisols varied from 1.30 to 19.90, 1.40 to 16.00 and 1.40 to 11.40 g kg^{-1} with a mean value 5.00, 4.50 and 3.80 g kg^{-1} respectively from Soils of Ambajogai tahsil in Beed district

Electrical conductivity of Ausa tahsil soils varied between 0.28 to 0.98 dS m^{-1} (Table 1). All the 50 soil Samples (100 per cent) from Inceptisols, were found safe in EC (Table 3 and figure 3), thus it is found that there was no remarkable accumulation of soluble salts in soils because of sufficient flushing and leaching of soluble salts from Upper into lower layers, which happens might be due to various agronomic practices, frequently irrigation of crops and light textured nature of the soils. Hiray and Takankhar (2013) [5] reported that the EC of soils from Tuljapur tahsil of Osmanabad varied from 0.110 to 0.810, 0.100 to 0.930 and 0.130 to 1.000 dS m^{-1} in Vertisols, Inceptisols and Entisols respectively.

The data on Calcium carbonate ($CaCO_3$) content in soil is varied from 20 to 92 g kg^{-1} with a mean value of 46.8 g kg^{-1} (Table 1). Among 50 soil samples, 35 (70 per cent) samples were non-calcareous while remaining 15 (30 per cent) samples were found calcareous in nature (Table 4 and figure 4). Presence of such nature of soils might be due to hyper thermic temperature regime and less amount of precipitation as compared to annual evapotranspiration, also the variations found in available $CaCO_3$ would be due to varying range of pH and clay content which alleviate the accumulation of $CaCO_3$ in studied soils. Waghmare *et al.* (2008) [9] observed that the range of $CaCO_3$ in soils was varied from 0.88 to 12.6 per cent with the mean value of 4.88 per cent, which shows non-calcareous to calcareous nature of soils from Ausa tahsil in Latur district.

Status of available Major nutrients in soils of Ausa Tahsil

The available Nitrogen content of soils from Ausa tahsil were ranged from 185 to 360 kg ha^{-1} with an average value of 264.56 kg ha^{-1}(Table 1). Out of 50 soil samples from Inceptisols, 29 (58 per cent) were low while 21 (42 per cent) samples comes under moderate category (Table 5 and figure 5). This might be due to the differential cultivation management, difference in soil physiographic properties, removal of N by growing of exhaustive crops along with limited addition of Nitrogen via organics, less accumulation of OM, leaching losses, Denitrification-fixation and volatization. Nirawar *et al.* (2009) [8] stated that the available N content from Ahmedpur tahsil of Latur district was varied from 100.35 to 323.00 kg ha^{-1}.

The content of available Phosphorous from the soils of studied area was ranged from 10.2 to 18.5 kg ha^{-1} with a mean value of 13.73 kg ha^{-1} (Table 1). Out of 50 soil samples (Table 5 and figure 6) of Inceptisols, 36 (72 per cent) were found low category, while only 14 (28 per cent) samples noted under moderate content of available Phosphorous. The low availability of P content in soils might be caused of frequent variations in soil properties *i.e.* pH, OM content, texture and various agro-soil management practices and also due to increase level of clay content in soil and higher amount of Fe and Al Hydrous oxides. Shinde *et al.* (2014) [5] reported that the available P content was ranged from 2.42 to 19.62 kg ha^{-1} with a mean value of 10.23 kg ha^{-1} from udgir tahsil in Latur district.

The available Potassium content in Inceptisols soils of Ausa tahsil was ranged from 245 kg ha^{-1} to 890 kg ha^{-1} with a mean value of 584.32 kg ha^{-1}(Table 1). Among the 50 soil samples of Inceptisols, 1 (2 per cent) samples were under moderately high category, while only 1 (2 per cent) was in high category,

however 48 (96 per cent) samples were noted under very high in available K content (Table 5 and figure 7). Higher content of available potassium resulted in the soils of Ausa Tahsil of Latur district might be due to the persistence of K rich minerals in the Parent material, with presence of high clay content like Feldspars, mica and Illite etc. Waghmare *et al.* (2009) [20] reported that the available potassium content in black soils of Ausa tahsil of Latur district varied from 141.45 to 1419 kg ha^{-1} with mean value of 532.20 kg ha^{-1}, this value indicated that soils of Ausa tahsil were medium to high in available K content.

Table 1: Range and average value of soil site characteristics

Parameters	pH	EC (dS m^{-1})	OC (g kg^{-1})	$CaCO_3$ (g kg^{-1})	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
Ranges	7.1-8.6	0.28-0.98	3.1-7.5	20-92	185-360	10.2-18.5	245-890
Mean	7.72	0.66	5.2	46.8	264.56	13.73	584.32

Table 2: Sample and Percentage value of Soil pH and OC from studied area

Parameters							
		< 5.5 (Str Acid.)	5.5 – 6.0 (Mod.Acid.)	6.0 – 6.5 (Sli.Acid.)	6.5 – 7.5 (Neu.)	7.5-8.5 (Mod. Alk.)	< 8.5 (Str.Alk.)
pH	Samples	-	-	-	17	32	1
	Percentage	-	-	-	34	64	2
OC		< 2.0 (V. Low)	2.1 – 4.0 (Low)	4.1 – 6.0 (Mod.)	6.1 – 8.0 (Mod. High)	8.1 – 10 (High)	> 10 (V. high)
	Samples	-	6	33	11	-	-
	Percentage	-	12	66	22	-	-

Table 3: Sample and Percentage value of Soil EC from studied area

Parameters					
EC		< 1.0 (No deleous.)	1.0 – 2.0 (Critl. For germ.)	2.0 – 3.0 (Critl for sen.crop)	>3.0 (Injurs. For crop)
	Samples	50	-		
	Percentage	100		-	-

Table 4: Sample and Percentage value of Soil $CaCO_3$ from studied area

Parameters				
$CaCO_3$		<50 (Non-Calcareous)	50 -150 (Calcareous)	>150 (Highly Calcareous)
	Samples	35	15	-
	Percentage	70	30	-

Table 5: Sample and Percentage value of available soil nutrients from studied area

Parameters							
Avail. N (kg ha^{-1})		< 140 (Very Low)	141-280 (Low)	281-420 (Mod)	421 – 560 (Mod. High)	561-700 (High)	> 701 (Very high)
	Samples	-	29	21	-	-	-
	Percentage	-	58	42	-	-	-
Avail. P (kg ha^{-1})		< 7 (Very Low)	8-14 (Low)	15-21 (Mod)	22-28 (Mod. High)	29-35 (High)	>35 (Very high)
	Samples	-	36	14	-	-	-
	Percentage	-	72	28	-	-	-
Avail. K (kg ha^{-1})		< 100 (Very Low)	101-150 (Low)	151 –200 (Mod)	201 – 250 (Mod. High)	250-300 (High)	> 300 (Very high)
	Samples	-	-	-	1	1	48
	Percentage	-	-	-	2	2	96

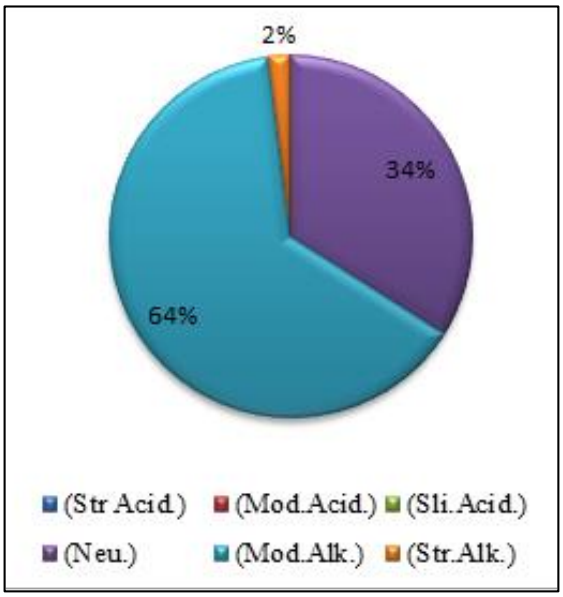

Fig 1: Diagrammatic representation of soil pH from studied area

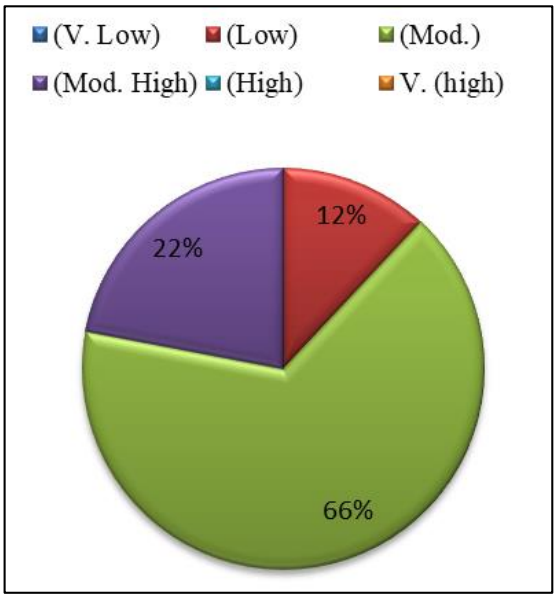

Fig 2: Diagrammatic representation of soil OC from studied area

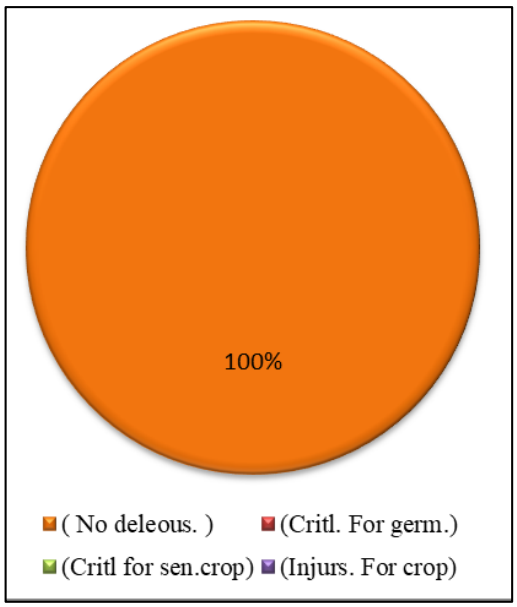

Fig 3: Diagrammatic representation of soil EC from studied area

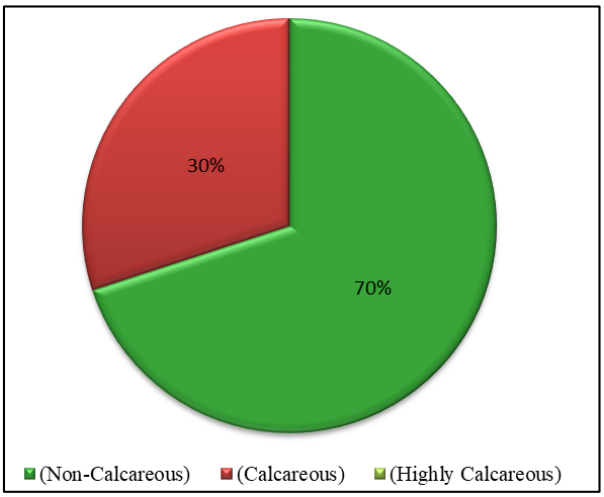

Fig 4: Diagrammatic representation of soil $CaCO_3$ from studied area

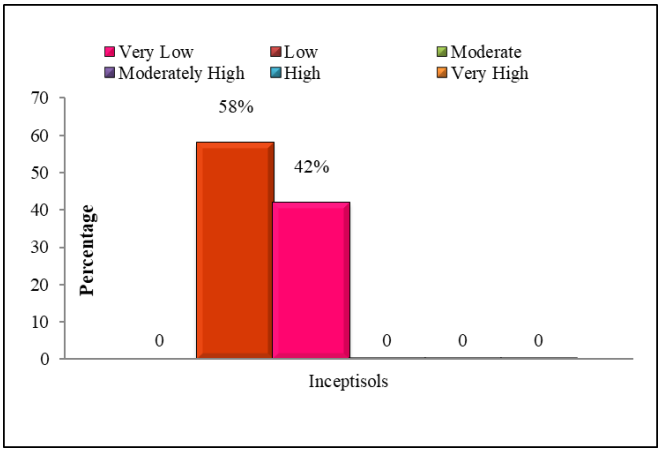

Fig 5: Diagrammatic representation of available N from studied area

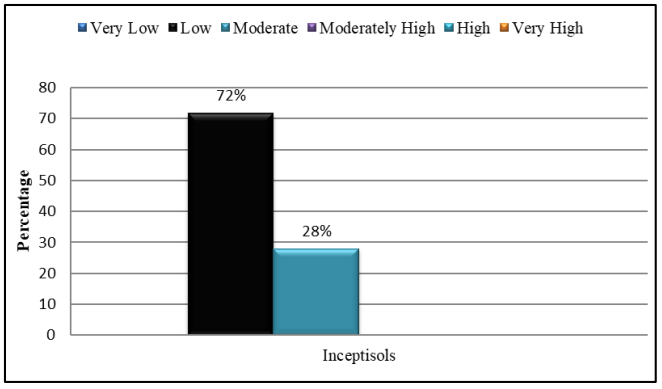

Fig 6: Diagrammatic representation of available P from studied area

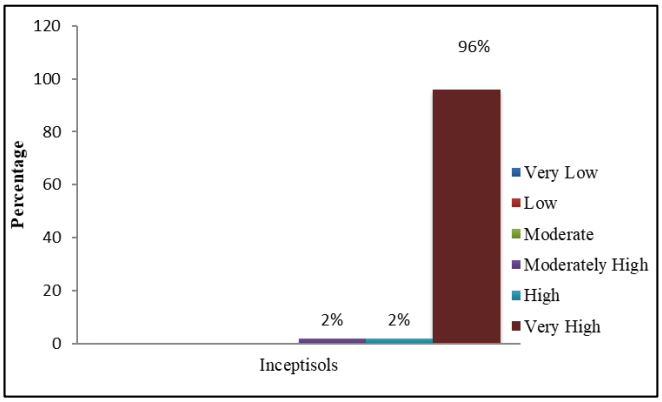

Fig 7: Diagrammatic representation of available K from studied area

Nutrient index Value (NIV) of Inceptisols Soils from Ausa tahsil

Considering soil nutrient index for soils of Ausa Tahsil represented in table no 6, it is revealed that this soil was mostly distributed under Low for available Nitrogen, low for available Phosphorous while very high for available Potassium for fertility index. The six tier NIV resulted according to Ramamoorthy and Bajaj (1969) [12] was 1.21 for available N, 0.56 for Available P, whereas 2.95 for available K respectively, against the NIV 0.75 – 1.25 for Low and > 2.75 for Very high fertility status of area (Table 6 and figure 8). On the basis of resulted nutrient index value for available Nitrogen soils from Ausa tahsil was categorized in very low to low content. As Nitrogen already the limiting nutrient for the growth and development of plants, reason behind this might be due to hot and dry climate condition associated with this region, limited addition of Nitrogen via organics, less accumulation of OM in these soils etc. To overcome these critics it is mandatory to apply organic wastes and matter as an important source of nutrient to the agricultural soils, also expected to added N fertilizers to the greater magnitude.

The available Phosphorous status in Ausa tahsil soils was found in category very low to low, this might be due to frequent fluctuation in soil properties and also Continuous mining by the crops from soils and higher amount of $CaCO_3$ in these soil which get fix the native and applied phosphorous in soil, to enrich such agricultural field it can be supplemented by applying Phosphorous rich fertilizers to the soils.

The NIV of Available potassium reported that the soils from studied area were found under very high fertility status, such higher availability of potassium in soils might because of the K bearing minerals and high content of clay present in the soils.s

Table 6: Nutrient Index Value of inceptisol order from studied area

Sr. No.	Available Nutrients	NIV	Category
		Inceptisols	
1	N	1.21	Low
2	P	0.56	Very Low
3	K	2.95	Very High

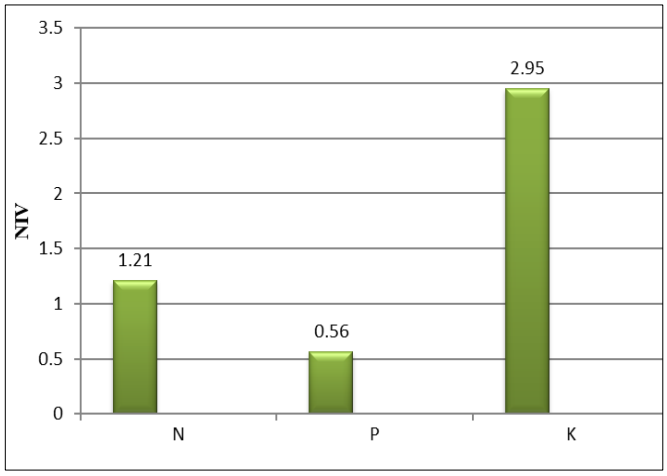

Fig 8: Nutrient Index Value for Inceptisols soil of Ausa Tahsil

Relationship between soil characteristics and available N, P and K in Inceptisols

The data on correlation between Physico chemical properties with available nutrients status of Inceptisols were depicted in (Table 7). The data indicated that soil pH of the Inceptisols showed positively significant correlation with available N (r= 0.619**), available P (r= 0.639**) and with available K (r= 0.777**) respectively. Similar positive correlation of pH with other soil properties and available N, P and K was also reported by Shukla (2011) [14].

The Electrical conductivity of Inceptisols, Entisols and Vertisols soils was found significant correlation with available N (r= 0.358*), available P (r= 0.376**) and available K (r= 0.697**) these results are in line with the results reported by Kashiwar *et al.* (2019) [7].

The organic carbon content was found significantly positive correlated with available N (r= 0.701**)) this relationship was found because in most of the soils, available N occurred in organic forms. Available P also showed significant relationship (r= 0.570**) This significant positive relationship of available P with EC might be due to the presence of more than 50 per cent of phosphorus in organic forms and after the decomposition of O.M as humus is which formed complex with Aluminium and Iron that worked as a protective cover for P fixation with Al and Fe thus reduce phosphorus adsorption / phosphate fixation. Further significantly positive correlation was observed with available K (r= 0.688**) respectively. Similar findings were also noticed by Verma *et al.* (2013) [16].

The calcium carbonate from Inceptisols was significantly correlated with available N (r= 0.334*), and available P (r= 0.494**) whereas $CaCO_3$ was showing non-significant relationship with available K (r= 0.246^{NS}) in Inceptisols, This might be due to creation of favourable soil environment with presence of high organic matter and also related with high clay content in soil. Similar results were also indicated by Waghmare *et al.* (2007) [18].

Table 7: Correlation between physico chemical properties and available nutrients in Inceptisols

Parameters	N	P	K
pH	0.619**	0.639**	0.777**
EC	0.358*	0.376**	0.697**
OC	0.701**	0.570**	0.688**
$CaCO_3$	0.334*	0.494**	0.246^{NS}

* And ** Indicates significance of values at P=0.05 and 0.01, respectively

Conclusion

It can be concluded that most of the Inceptisols of Ausa tahsil from Latur District showed low to moderate status in available N and P, moderately high to very high level in available K and characterized under neutral to moderately alkaline in soil reaction (pH) and less than 1.0 dS m-1 soluble salt content (EC) which comes under safe limit for all soils. The organic carbon level exhibited low to moderately high whereas non-calcareous to calcareous in nature were found. The Physico chemical properties (pH, EC, OC and $CaCO_3$) of soils from order Inceptisols showed strongly positive and significant relation with available nutrients (N, P and K) however $CaCO_3$ showed non-significant relation with available K. Hence, the soils require attention regarding nutrient management practices and regular monitoring of soil health for better crop production, in future.

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